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## Measurement of Depression Treatment among Patients Receiving HIV Primary Care: Whither the Truth?

Bethany L. DiPrete<sup>1,\*</sup>, Brian W. Pence<sup>1</sup>, David J. Grelotti<sup>2</sup>, and Bradley N. Gaynes<sup>3</sup>

<sup>1</sup>Department of Epidemiology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States of America

<sup>2</sup>Department of Psychiatry, University of California, San Diego, United States of America

<sup>3</sup>Department of Psychiatry, School of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States of America

### Abstract

**Background**—Prescription records, manual chart review, and patient self-report are each imperfect measures of depression treatment in HIV-infected adults.

**Methods**—We compared antidepressant prescription records in an electronic data warehouse with antidepressant treatment and psychotherapy identified via manual chart review and self-report for patients at 6 academic HIV treatment centers. We examined concordance among these three sources, and used latent class analysis (LCA) to estimate sensitivity and specificity of each measure.

**Results**—In our charts sample (n=586), 59% had chart indication of “any depression treatment” and 46% had a warehouse prescription record. Antidepressant use was concordant between charts and data warehouse for 77% of the sample. In our self-report sample (n=677), 52% reported any depression treatment and 43% had a warehouse prescription record. Self-report of antidepressant treatment was consistent with prescription records for 71% of the sample. LCA estimates of sensitivity and specificity for “any depression treatment” were 67% and 90% (warehouse), 87% and 75% (self-report), and 96% and 77% (chart).

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\* **Corresponding Author:** Bethany L. DiPrete, Department of Epidemiology, Gillings School of Global Public Health, 2102 McGavran-Greenberg Hall, Chapel Hill, NC 27599. Phone: +1 (919) 966-7446; Fax: +1 (919) 966-6714. diprete@email.unc.edu.

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#### Contributors:

BWP and BNG contributed to the acquisition of data. BWP conceived and designed the experiments. BLD and BWP analyzed the data. BLD drafted the manuscript. BWP, BNG, and DJG assisted with the interpretation of the data and critically revised the manuscript for important intellectual content. All authors take responsibility for and approve the final version of the manuscript.

#### Institutional Review Board:

Data collection procedures are approved by the institutional review boards (IRBs) at each Center for AIDS Research (CFAR) Network of Integrated Clinical Systems (CNICS) site. Ethical approval for these analyses was provided by the Institutional Review Board at the University of North Carolina at Chapel Hill.

#### Conflict of interest:

Brian W. Pence has received a speaking honorarium from MSD. All other authors declare that they have no conflicts of interest.

**Limitations**—There is no gold standard to measure depression treatment. Antidepressants may be prescribed to patients for conditions other than depression. The results may not be generalizable to patient populations in non-academic HIV clinics. Regarding LCA, dependence of errors may have led to overestimation of sensitivity and specificity.

**Conclusions**—Prescription records were largely concordant with self-report and chart review, but there were discrepancies. Studies of depression in HIV-infected patients would benefit from using multiple measures of depression treatment or correcting for exposure misclassification.

### Keywords

Depression; HIV; Antidepressive agents; Self Report; Electronic Health Records; Misclassification

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### Introduction

Depression is the most common mental health comorbidity among persons living with HIV (PLWH), with estimates of 20-30% affected (Bing et al., 2001; Ciesla and Roberts, 2001; Pence et al., 2006). Depression in PLWH is associated with adverse health and behavior outcomes, including reduced adherence to antiretroviral treatment (ARV) (Gonzalez et al., 2011; Mugavero et al., 2006), reduced CD4 counts, increased viral load (Pence et al., 2007), and increased rates of AIDS-related morbidity and mortality (Gonzalez et al., 2011; Horberg et al., 2008; Todd et al., 2017). However, depression is under-diagnosed and frequently untreated in HIV-infected patients (Asch et al., 2003; O’Cleirigh et al., 2015; Pence et al., 2012). Treatment interventions for depression, including treatment with antidepressants and mental health counseling, are shown to be effective in HIV-infected individuals (Himelhoch and Medoff, 2005; Himelhoch et al., 2007). Some studies suggest that depression treatment improves HIV medication adherence and viral suppression (Safren et al., 2016; Sin and DiMatteo, 2014; Tsai et al., 2010), although the evidence remains mixed (Pence et al., 2015; Pyne et al., 2011; Tsai et al., 2013). A better understanding of the impact of depression treatment on HIV outcomes in large, generalizable populations is crucial for defining the importance of improved mental health access for people living with HIV.

One avenue for gathering large-scale evidence on the impact of depression treatment on HIV outcomes is to leverage electronic health records (EHRs). EHRs make it possible to use prescription records to characterize depression treatment on a large scale and are increasingly used in depression research (Cholera et al., 2017; Zuniga et al., 2015). However, depression treatment characterized through EHR prescription records may be inconsistent with more labor-intensive measurement approaches, such as manual chart review or patient self-report. Electronic medication histories may be incomplete or contain discrepancies (Coletti et al., 2015; Lee et al., 2014; Linsky and Simon, 2013; Stewart and Lynch, 2012), especially among individuals taking many medications (Coletti et al., 2015; Lee et al., 2014; Linsky and Simon, 2013) or among those who receive prescriptions from offsite providers (Madden et al., 2016). Additionally, electronic prescription data may not capture patients who receive mental health counseling without antidepressant treatment, or may capture patients who are prescribed antidepressants for conditions other than depression, such as patients prescribed antidepressants for anxiety or smoking cessation. Therefore, a measure of depression treatment indicated solely by an electronic prescription

record could result in misclassification of depression treatment for HIV-infected individuals, affecting the validity of conclusions.

Provider notes may capture patient information regarding counseling or other treatment that is not distinguished in electronic prescription records, and serve to provide context for the patient narrative (Kobus et al., 2013; Turchin et al., 2009). However, provider notes in the EHR may not be comprehensive due to factors such as patient volume or the type of information sought (Kobus et al., 2013; Pakhomov et al., 2008; Turchin et al., 2009), and chart abstraction can be labor-intensive and challenging to standardize. Patient report has been shown to be a useful supplement to EHR data (Coletti et al., 2015; Kozak et al., 2012; Pakhomov et al., 2008), as documentation of treatment for depression in EHRs is less robust than medical documentation in other areas of healthcare, and clinical information on mental health is frequently missing (Kobus et al., 2013; Madden et al., 2016; Tomines et al., 2013). While electronic prescription records may miss individuals with prescriptions from an offsite clinic or those who receive counseling without antidepressants, patient reports provide the opportunity to capture this information. But patient reports may contain inaccuracies or be subject to missing information because of patient unwillingness to report particular types of sensitive information or because patients may be unfamiliar with their diagnosis or treatment regimens (Lee et al., 2014; Pakhomov et al., 2008; Stewart and Lynch, 2012).

Each of these sources may provide imperfect information for some portion of patients receiving treatment for depression when used alone as a measure of treatment. Electronic prescription records housed in data warehouses are increasingly used in depression research (Bengtson et al., 2016b; Cholera et al., 2017), but little information exists regarding how well this data source captures patients receiving depression treatment. Thus, consideration must be taken to understand what is being measured and what patient data is missed by each data source when conducting research on depression treatment among PLWH using electronic prescription data. This study seeks to measure how accurately each data source, and electronic prescription records in particular, can identify patients receiving treatment for depression, including antidepressants or mental health counseling. To this end, this paper evaluates concordance of depression treatment as measured from EHR antidepressant prescription data, manual chart review including provider notes, and patient self-report to inform research practices on depression treatment among PLWH.

## Methods

### Study population and data collection

Data come from the Center for AIDS Research (CFAR) Network of Integrated Clinical Systems (CNICS) observational clinical cohort. CNICS is a collaboration of eight academically affiliated HIV clinics across the United States (Kitahata et al., 2008). Each clinic has established a database capturing information routinely collected by electronic health records and other institutional data systems. To date, the CNICS cohort includes over 32,000 HIV-infected adults in routine HIV clinical care. Nearly all patients consent to have their data captured. Data are de-identified and uploaded to a central CNICS repository on a quarterly basis. CNICS data elements include demographics, medications, health care utilization, clinical diagnoses, laboratory values and vital signs, vital status, antiretroviral

resistance, and biologic specimens. CNICS sites have also integrated patient-reported outcomes (PROs) into routine clinical care to assess depression and anxiety, adherence, drug and alcohol use, sexual risk behaviors, symptom burden, physical activity level, body morphology, and quality of life. Data quality procedures have been previously described (Kitahata et al., 2008). Data collection procedures are approved by the institutional review boards (IRBs) at each site, and all participants provide written informed consent. Ethical approval for these analyses was provided by the IRB at the University of North Carolina at Chapel Hill.

For the purposes of this validation study, two new PRO items were integrated at 6 CNICS sites for 54-288 patients per site between 2013 and 2015 (total n: 677). The new PRO items, specifying the past three months, asked participants (1) whether they had seen any providers (psychiatrist; other doctor who prescribes antidepressant medications; therapist, counselor, or psychologist; alternative provider; or other provider) for mental health counseling, antidepressants, or other treatment and (2) whether they had taken antidepressants, herbs, homeopathic medicines, or other medicines for depression. Patients answered yes or no to each type of provider and each type of medication.

At each of the 6 sites, 46-50 patients selected randomly from those who had completed the new PROs (sample A) and 48-50 patients selected randomly from all patients keeping an HIV primary care appointment in the prior 12 months (sample B) were identified for manual chart review (n=586 total). Trained and experienced abstractors reviewed medical records and chart notes from HIV and on-site behavioral health providers for the 12-month period prior to the PRO (for sample A) or prior to the attended appointment which led to the patient's inclusion in the sample (for sample B). Abstractors recorded any indication that the patient was receiving antidepressant treatment, counseling for depression, or mental health treatment of unknown type during the review period, including indications that the patient was receiving treatment offsite (e.g. from a community mental health agency). A chart indication of mental health treatment was classified as being of unknown type if the patient was recorded as receiving mental health treatment, but the provider had not made any note regarding the specific type of treatment the patient was receiving. Treatment was classified according to whether it was being provided in the HIV clinic, in the larger health system whose records would be captured in the CNICS data warehouse, or outside of the health system. Abstractors were instructed not to include meetings with clinic social workers unless there was a clear indication that the purpose of the meeting was to address depression, since social workers at these clinics frequently meet with patients to address a wide range of social service needs.

## Measures

Depression was measured via the Patient Health Questionnaire-9 (PHQ-9), (Kroenke et al., 2001) which was included as part of the PRO administration. The PHQ-9 assesses presence of the nine DSM-V criteria symptoms for depression in the past two weeks and is well-validated among HIV-infected adults (Crane et al., 2010). A PHQ-9 score  $\geq 10$  (on a scale of 0-27) is indicative of probable major depressive disorder (Kroenke and Spitzer, 2002; Kroenke et al., 2001; Mulvaney-Day et al., 2017).

Our goal was to compare depression treatment measured from antidepressant prescriptions captured in the CNICS data warehouse to depression treatment measured from the PROs and chart review. Antidepressant prescription in the data warehouse was defined as a record of a prescription of any selective serotonin reuptake inhibitor, serotonin-norepinephrine reuptake inhibitor, or other second-generation antidepressant (bupropion or mirtazapine) that was active during the time period covered by the PRO (3 months) or the chart review (12 months). For the PRO and chart review data, we constructed separate measures of any antidepressant prescription, any mental health counseling, and any depression treatment (medication or counseling). For chart review data, we created these measures for both the full 12-month period, to compare to the data warehouse, and for only the 3 months corresponding to the PRO recall period.

## Analyses

Table 1 displays the two-way comparisons considered between each of the three data sources: data warehouse, PROs, and chart records. As each of these data sources is likely to have strengths and weaknesses, we did not consider any one of them to be a reference standard.

For participants with both warehouse and PRO information ( $n=677$ ), we compared (1) warehouse versus PRO indication of antidepressant prescription, (2) warehouse record of antidepressant prescription versus PRO indication of counseling and (3) warehouse record of antidepressant prescription versus PRO indication of any depression treatment.

For participants with both warehouse and chart review information ( $n=586$ ), we compared (1) warehouse versus chart records of antidepressant prescription, (2) warehouse record of antidepressant prescription versus chart record of counseling, and (3) warehouse record of antidepressant prescription versus chart record of any depression treatment. We examined these comparisons in the overall sample as well as separately in the subsamples that were selected from PRO completers (sample A) and from all clinic attendees (sample B).

Finally, for participants with both PRO and chart review information ( $n=301$ ), we compared (1) PRO versus chart record of antidepressant prescription, (2) PRO versus chart record of counseling, and (3) PRO versus chart record of any depression treatment.

As each of these three data sources is likely error-prone, we applied latent class analysis (LCA) to estimate the sensitivity and specificity of any depression treatment measured from each data source relative to the latent, or not directly measured, construct of true depression treatment status. LCA is used when multiple imperfect measures can be leveraged to triangulate on the desired but unmeasured true construct (Walter and Irwig, 1988), and has been used previously to estimate the performance of mental health measures among PLWH (Pence et al., 2009). LCA was fit using the disk operating system program Latent.exe (developed by Steven Walter, walter@mcmaster.ca; personal communication, May 28, 2007). All other analyses were conducted using Stata 14 (StataCorp: College Station, TX).

## Results

Participants in the PRO (n=677) and chart review (n=586) samples were majority male (81% and 81%, respectively), white non-Hispanic (51% and 53%), on ART (91% and 89%), had median CD4 counts >500 cells/mm<sup>3</sup> (59% and 59%), and had an undetectable viral load (74% and 73%). The median age in each sample was 47 years. The prevalence of depression in each sample was high: 42% of patients in the PRO sample and 45% in the chart review sample had a PHQ9 ≥ 10 (Table 2).

Among participants who completed the PRO (n=677), 52% reported any depression treatment in the past 3 months, including antidepressant treatment alone (14%), counseling alone (8%), or both (30%) (Table 3). Of these same participants, 43% had a record of an antidepressant in the CNICS data warehouse during the corresponding 3-month window. Of the participants with chart abstraction data (n=586), 59% had a record of any treatment for depression during the 12-month chart abstraction period, including antidepressant treatment alone (42%), counseling alone (4%), or both (13%), and 46% had a CNICS warehouse record of an antidepressant during the corresponding 12-month period (Table 3). Three percent of patients were classified as receiving mental health treatment of unknown type at some point during follow up (data not shown).

Overall, chart records and the data warehouse had consistent information regarding antidepressant use for 77% (442) of patients in the past 12 months (Table 4). Of patients with a chart indication of an antidepressant prescription, 72% were classified in the data warehouse as taking an antidepressant; of those with no chart report of an antidepressant, 84% were classified as not taking an antidepressant. Individuals receiving only offsite antidepressant treatment accounted for 6% of individuals with a chart indication of antidepressant use. Thus, most discrepancies between chart report of antidepressant use and warehouse prescriptions were not due to offsite prescriptions. Concordance between chart record of “any depression treatment” and the warehouse classification was very similar to the concordance between chart record of antidepressant treatment and the warehouse classification. Although 17% of participants had a chart record of counseling, few were receiving counseling without also having a record of an antidepressant (Table 3). Concordance between warehouse and chart review was similar when considering the two different samples of patients selected for chart review (data not shown).

Patient-report of antidepressant use was less consistent than chart records with warehouse data (Table 4). Of patients who self-reported antidepressant use, 67% were classified as taking an antidepressant in the data warehouse; and of those who did not self-report taking an antidepressant, 74% did not have an antidepressant prescription record in the data warehouse. Mental health counseling was reported by 38% (253) of patients and of those, 41% had no record of an antidepressant prescription in the data warehouse. Overall, concordance of self-report of any depression treatment with warehouse prescription records was slightly less than concordance of self-report of antidepressant treatment with warehouse prescription records: 61% of patients reporting “any depression treatment” had a warehouse antidepressant prescription, but 76% of patients who denied treatment had no evidence of a prescription record in the data warehouse.

Additionally, we compared PROs with chart review data for the 301 patients who completed the PRO and for whom a chart review was completed (Table 5). This comparison was the least consistent with respect to antidepressant use. Of patients who reported antidepressant use, 57% had a chart record of antidepressant treatment; of those who denied antidepressant treatment, 78% had no chart record of an antidepressant prescription. Discrepancies between PROs and chart data stemmed more from patients who self-reported antidepressant use but had no evidence of antidepressant treatment in the chart record (24%) than from those who denied antidepressant treatment but had a chart record of treatment (10%). PROs and chart data were less consistent for mental health counseling. While there was concordance between patient self-report and chart record of mental health counseling for 56% of patients, most patients who reported counseling had no indication in the chart record (84%). Overall, patient report of “any depression treatment” was consistent with the chart record for the majority of patients (65%). Among patients who self-reported depression treatment, 58% had a chart indication of treatment; of those who denied treatment, 77% had no chart record of depression treatment.

In the subsample of patients represented in all three data sources (n=292), LCA estimates of sensitivity and specificity for capturing the true latent construct of any depression treatment were 67% (95% CI: 0.62-0.71) and 90% (0.85-0.94) for prescription records in the CNICS data warehouse, 87% (0.84-0.91) and 75% (0.69-0.81) for self-report of any depression treatment, and 96% (0.93-0.98) and 77% (0.70-0.84) for chart indication of any depression treatment. When warehouse, self-report, and chart review were limited to measures of antidepressant treatment only, LCA estimates of sensitivity and specificity for measurement of any antidepressant use were 69% (0.64-0.73) and 91% (0.87-0.95) for the warehouse, 81% (0.77-0.85) and 87% (0.83-0.92) for patient self-report, and 92% (0.89-0.95) and 84% (0.77-0.90) for chart indication (Table 6).

## Discussion

In this study, we compared the concordance of antidepressant treatment as captured in electronic health record databases with manual chart review and patient self-report of depression treatment. The majority of patients had consistent treatment information in the medical chart, CNICS data warehouse, and patient reports. Chart records and the data warehouse were most consistent—three quarters of patients with chart abstraction data had both warehouse prescription records of antidepressants and provider notes documenting treatment of depression with antidepressants, or had no evidence of antidepressant treatment in both data sources. Yet, discrepancies were present in each data source comparison. Over a quarter of patients who self-reported antidepressant treatment or who had documentation of antidepressants in the medical chart did not have a warehouse prescription record in the corresponding time window. In comparisons between chart data and warehouse data, the majority of inconsistent data stemmed from patients without a prescription record but with chart evidence of antidepressant treatment. This is consistent with previous evidence of inconsistencies and missing data from medication records (Coletti et al., 2015; Lee et al., 2014; Linsky and Simon, 2013; Stewart and Lynch, 2012).

LCA results suggested that chart indication of depression treatment had the highest sensitivity, whereas warehouse prescription records had the lowest. Warehouse prescription records had the highest specificity while patient self-report had the lowest. These estimates are consistent with the hypothesis that warehouse prescription records underestimate depression treatment by missing individuals receiving treatment offsite or psychotherapy alone, but are less likely than chart records or PROs to misclassify untreated individuals as receiving depression treatment.

Increasingly, studies are using routinely captured electronic medical record data to address questions such as the effect of depression treatment on clinical outcomes (Bengtson et al., 2016a; Sowa et al., 2016). Thus, it is important to be able to account for misclassification errors stemming from the use of electronic medical records. Yet few studies have examined the accuracy of measurement of depression treatment in such large databases (Kobus et al., 2013; Madden et al., 2016). To our knowledge, this study is among the first to compare multiple measures of depression treatment in HIV-infected patients from different documentation sources. Each data source provides rich patient data, but each is also an imperfect representation of a patient's full medical picture. Warehouse prescription records provide vast quantities of data on large numbers of patients that are easily accessible by researchers. However, prescription records may have inconsistencies with PROs and chart reviews, which are more labor-intensive. Inconsistencies may arise because prescriptions for antidepressants might be provided for reasons other than depression treatment (e.g., bupropion for smoking cessation), and prescription records may not document the rationale for the treatment or capture prescriptions obtained offsite. Prescription records also do not capture mental health counseling and do not account for patient non-adherence. Conversely, patient reports are imperfect because the patient's definition of treatment in self-report may conflict with the study definition. For example, patients may have a broader definition of counseling and thus reported counseling that was not in fact evidence-based, sufficient-dose counseling for depression. Similarly, HIV providers may record evidence of depression treatment in their chart note based on conversations with their patients, but the definition of treatment may again not match the study definition of treatment. However, both chart notes and patient self-report may provide evidence of offsite management of depression or evidence-based counseling that may not be captured in the data warehouse.

This study highlights that defining depression treatment as treatment with antidepressants may miss those patients who receive treatment in the form of mental health counseling without antidepressants or who receive treatment offsite. Studies have shown that counseling is an effective form of treatment for depression among patients infected with HIV (Himmelhoch et al., 2007; Sin and DiMatteo, 2014); however, not all counseling is protocolled, evidence-based therapy. Only 4% of participants based on chart review and 8% based on self-report were receiving counseling without medication, and the concordance of warehouse prescriptions with "any depression treatment" was similar to its concordance with antidepressant treatment alone. LCA estimates suggested that although warehouse prescription records have high specificity, they have only moderate sensitivity. Thus, to reduce misclassification errors, future studies would benefit from using multiple measures of depression treatment to identify HIV-infected patients who are being treated for depression. The present study provides a basis for applying quantitative bias analysis methods to correct



for measurement error in studies that examine depression treatment and health outcomes among PLWH. While there is no gold standard to measure depression treatment, and thus no perfect estimate of misclassification, the information presented in this paper may provide guidance on the choice of probabilities of misclassification in future studies.

Several study limitations exist that must be considered when interpreting the results of this study. First, there is no gold standard for sources of data on depression treatment. Data warehouse prescription records, manual chart reviews, and patient reports are three imperfect sources. Patients may receive prescriptions for antidepressants for conditions other than depression, thus would be misclassified as receiving depression treatment. Second, there was inconclusive information about prescription dates in the data warehouse for a small subset of patients, who thus were not included in analyses. These patients did not have information about day or month of the antidepressant prescription, so we could not verify whether their prescription was active during the defined chart or PRO window. Self-report of treatment for depression was restricted to antidepressant use or contact with a mental health professional, thus responses indicating alternative treatments such as acupuncture or herbal remedies were excluded. This was deemed a reasonable exclusion as a minimal number of patients reported these alternative treatments, but further analyses may benefit from including alternative therapies in the definition of treatment interventions for depression. Regarding LCA, the validity of the sensitivity and specificity estimates is based on the assumption that classification errors (false positives and false negatives) are independent between the three tests, an assumption likely violated in this situation; such dependence of errors may have led to overestimation of sensitivity and specificity (Torrance-Rynard and Walter, 1997). Finally, while the study includes patients from 6 sites across the United States, the results may not be generalizable to patient populations in non-academic HIV clinics.

In summary, we found that prescription records are largely in agreement with patient self-report and manual chart review as measures of depression treatment, but some differences between the measures were noted. Defining treatment for depression as the use of antidepressants may result in misclassification of some patients who receive offsite medications or mental health counseling alone; however, in this study the proportion receiving counseling alone was small. To improve measurement of depression treatment, future studies should consider using multiple measures of depression treatment or applying quantitative bias analysis to correct for exposure misclassification.

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### Highlights

- There was concordance between the three data sources for the majority of patients.
- Prescription records may miss those receiving offsite treatment or counseling alone.
- Studies should use multiple measures of treatment or correct for misclassification.

**Table 1**

## Details of measures compared

Sources compared	Time frame	N	Constructs compared
Data warehouse and Chart review	Past 12 months	586	<i>Warehouse:</i> Antidepressant prescription, compared to <i>Chart:</i> Antidepressant prescription  <i>Warehouse:</i> Antidepressant prescription, compared to <i>Chart:</i> Counseling  <i>Warehouse:</i> Antidepressant prescription, compared to <i>Chart:</i> Any depression treatment
Data warehouse and PROs	Past 3 months	677	<i>Warehouse:</i> Antidepressant prescription, compared to <i>PRO:</i> Antidepressant prescription  <i>Warehouse:</i> Antidepressant prescription, compared to <i>PRO:</i> Counseling  <i>Warehouse:</i> Antidepressant prescription, compared to <i>PRO:</i> Any depression treatment
Chart review and PROs	Past 3 months	301	<i>Chart:</i> Antidepressant prescription, compared to <i>PRO:</i> Antidepressant prescription  <i>Chart:</i> Counseling, compared to <i>PRO:</i> Counseling  <i>Chart:</i> Any depression treatment, compared to <i>PRO:</i> Any depression treatment

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**Table 2**

Characteristics of the study samples

Characteristic	PRO sample* N=677 N(%) or median (IQR)	Chart review sample† N=586 N(%) or median (IQR)
Age	47 (37, 53)	47 (39, 53)
Gender		
Male	551 (81.4)	472 (80.6)
Female	126 (18.6)	111 (18.9)
Race/ethnicity		
White, non-Hispanic	342 (51.1)	307 (53.2)
Black, non-Hispanic	259 (38.7)	183 (31.7)
Hispanic	47 (7.0)	62 (10.6)
Other	21 (3.1)	25 (4.3)
On ART	609 (90.5)	507 (88.6)
CD4 count, cells/mm <sup>3</sup>		
200	72 (10.6)	65 (11.2)
201-500	204 (30.2)	171 (29.4)
>500	400 (59.2)	346 (59.5)
Viral load		
Undetectable, <50 copies/mL	498 (73.7)	427 (73.4)
Detectable, 50 copies/mL	178 (26.3)	155 (26.6)
PHQ9 10	269 (41.6)	241 (44.9)

\* Missing data: race/ethnicity 1.2%, on ART 0.6%, CD4 0.2%, viral load 0.2%, PHQ9 4.3%

† Missing data: age 0.5%, gender 0.5%, race/ethnicity 1.5%, ART 2.4%, CD4 0.7%, viral load 0.7%, PHQ9 8.2%

**Table 3**

## Measures of depression treatment frequency

Depression treatment measure	N (%)
<i>Patient-reported outcome (PRO): Past 3 months</i> * (n=677)	
Any depression treatment	354 (52.3)
Antidepressants alone	96 (14.2)
Counseling alone	57 (8.4)
Both antidepressants and counseling	201 (29.9)
<i>Chart review: Past 12 months</i> (n=586)	
Any depression treatment	346 (59.0)
Antidepressants alone	244 (41.6)
Counseling alone	25 (4.3)
Both antidepressants and counseling	77 (13.1)
<i>CNICS data warehouse</i> †	
In PRO sample (n=677): Any antidepressant, past 3 months	285 (43.3)
In chart review sample (n=586): Any antidepressant, past 12 months	262 (45.9)

\* Missing data: self-reported antidepressant use 0.6%

† Missing data: PRO sample 2.8%, chart sample 2.6%

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**Table 4**

## Concordance of measures of depression treatment

	Data warehouse: Any antidepressant?*	
	Yes	No
<i>Chart review: Past 12 months</i>		
Any antidepressant?		
Yes	221 (71.5)	88 (28.5)
No	41 (15.7)	221 (84.4)
Any counseling?		
Yes	62 (62.6)	37 (37.4)
No	200 (42.4)	272 (57.6)
Any depression treatment?		
Yes	226 (67.7)	108 (32.3)
No	36 (15.2)	201 (84.8)
<i>Patient-reported outcome: Past 3 months</i>		
Any antidepressant?		
Yes	189 (66.6)	95 (33.5)
No	95 (25.7)	275 (74.3)
Any counseling?		
Yes	149 (58.9)	104 (41.1)
No	136 (33.6)	269 (66.4)
Any depression treatment?		
Yes	209 (61.3)	132 (38.7)
No	76 (24.0)	241 (76.0)

\* Missing data: Chart sample 2.6%, PRO sample 2.8%

**Table 5**

Concordance of PRO and chart review (n=301)

	<i>Chart Review</i> N (Row %)	
	Yes	No
<i>PRO</i>		
Any antidepressant?*		
Yes	94 (56.6)	72 (43.4)
No	30 (22.4)	104 (77.6)
Any counseling?		
Yes	25 (16.3)	128 (83.7)
No	3 (2.0)	145 (98.0)
Any depression treatment?		
Yes	112 (58.0)	81 (42.0)
No	25 (23.2)	83 (76.9)

\* Missing data: PRO 0.3%

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**Table 6**

Latent class analysis estimates of sensitivity and specificity of each measure (n=292)

<b>Any Depression Treatment</b>				
<b>Measure</b>	<b>Estimated Sensitivity</b>	<b>95% C.I.</b>	<b>Estimated Specificity</b>	<b>95% C.I.</b>
Warehouse	0.67	0.62 – 0.71	0.90	0.85 – 0.94
PRO	0.87	0.84 – 0.91	0.75	0.69 – 0.81
Chart	0.96	0.93 – 0.98	0.77	0.70 – 0.84
<b>Antidepressant Treatment</b>				
<b>Measure</b>	<b>Estimated Sensitivity</b>	<b>95% C.I.</b>	<b>Estimated Specificity</b>	<b>95% C.I.</b>
Warehouse	0.69	0.64 – 0.73	0.91	0.87 – 0.95
PRO	0.81	0.77 – 0.85	0.87	0.83 – 0.92
Chart	0.92	0.89 – 0.95	0.84	0.77 – 0.90

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